Validating GPM Snow Water Equivalent Rate Estimates in Finland

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Approach:

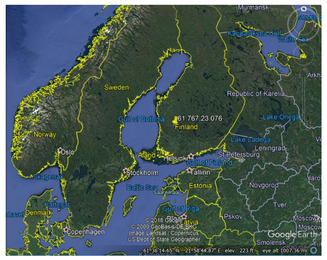
Hyytiälä, Finland. Case-specific Ze-S constructed based on snow physical properties per **von Lerber et al. 2017, 2018** (JAMC)
Ze-S applied to Ikaalinen (IKA) C-band radar and compared to GPM over winter snow events from 2014-2015 and 2017-2018.

- Masses of falling ice particles are retrieved via video disdrometer / Particle Imaging Package (PIP) measurements from Hyytiälä, Finland (64 km east of IKA radar)
- Mass-dimension (m-D) relations are sensitive to prevailing microphysical processes.
- Errors in observed geometry and measured PSD are determined by comparison of retrieved precipitation accumulation with weighing-gauge (Pluvio) measurements.
- *Event-specific* Ze-S determined from derived microphysical properties. Error source: microphysical properties vary with temporal scale O[minutes].
- Exponent of Ze-S (b) depends mainly on exponent of m-D relation.
- Coefficient of Ze-S (A) depends on intercept parameter N_0 of PSD and coefficients of m-D and v(D) relations.
- Changes in coefficient A for given N_0 linked to changes in liquid water path.

Case-specific Ze-S: $Ze = A * S^b$

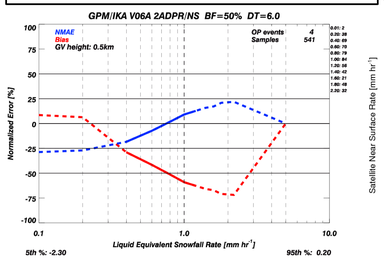
Date	A	b
2014/03/20	73.3	1.61
2014/11/06-07	233.3	1.55
2014/12/24	115.5	1.36
2014/12/30	44.6	1.22
2015/01/07	38.6	1.20
2015/01/12-13	83.7	1.34
2015/01/31	134.6	1.53
2015/03/30	115.5	1.36
2018/01/24	85.7	1.42
2018/02/01	82.5	1.76
2018/02/02	147.4	1.32
2018/04/02	56.4	1.42

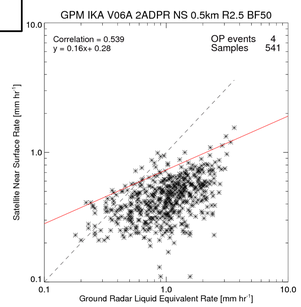
Location / IKA Radar Parameters	
IKA Location	61.77°N 23.08°E
Wavelength / Frequency	5.3 cm / 5.5 GHz
Beamwidth	1.0°
Gate Spacing	500 m
PRF	570 Hz
Scan strategy 5-min frequency	4-tilt volume 0.3°, 0.7°, 1.5° 3.0°
Antenna height	153 m above MSL

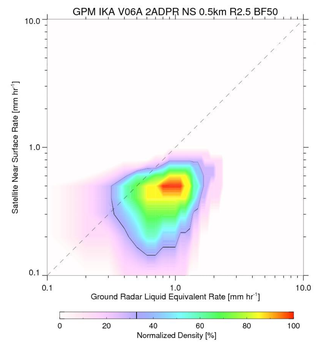


GPM DPR dual vs single frequency comparisons

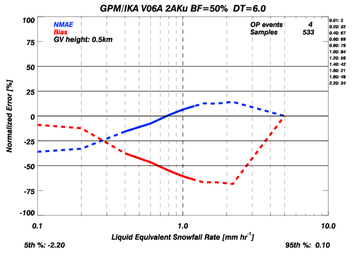
2ADPR V06A – Inner Swath (rays 12-36)
Dual-frequency

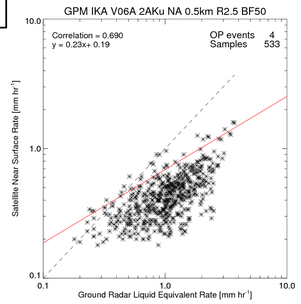


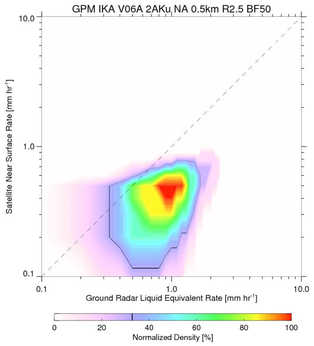




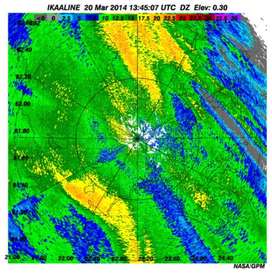
2AKu V06A – Inner Swath (rays 12-36)
Single-frequency





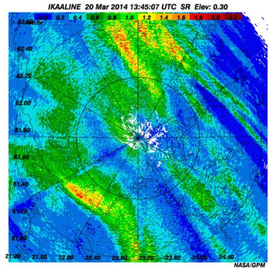


IKA Ground Radar Reflectivity → Derive mapped SWER



Reflectivity

- IKA Snow Event
- Determine event-specific and snow-density tuned Z-S derived using Precipitation Imaging Package (PIP) and Pluvio.
- Determine SWER field in polar coordinates from calibration-adjusted radar reflectivity



SWER

Methodology for ground radar / GPM comparisons

Grid and average GV data within DPR / GMI pixel

Gridded GV height: 0.5 km
Horiz Res: 1.0 km; Vertical Res: 0.25 km

Average GV rate data within DPR/GMI pixels
DPR/CMB: 5x5 km²; GMI: 25x25 km²

Generate precipitation rate data "Pairs"

Snapshot data are matched temporally and spatially. Multiple overpass dates combined.

Time difference between GV scans and GPM overpasses are within 6 minutes (adjustable).

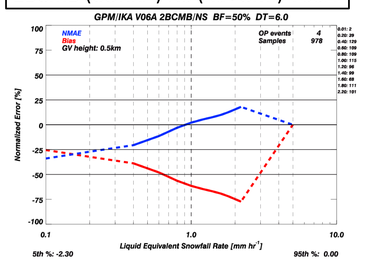
Generate plots (Bias/NMAE; Scatter; Density)

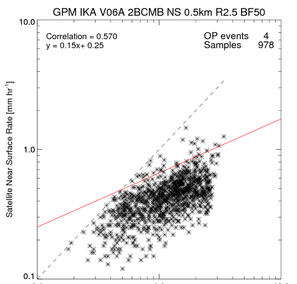
Conditional Analysis:
GV mean rate and DPR/GMI pixel > 0 mm/hr

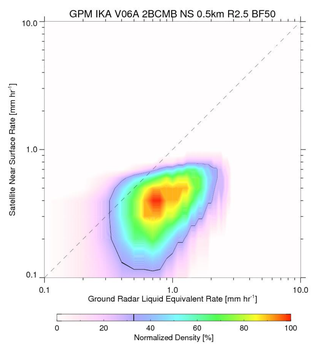
Beam-Filling requirement 50% or 90%:
GV data must fill DPR/GMI pixel at required %.

Combined Radar Radiometer (CORRA) comparisons

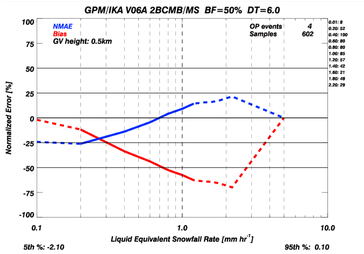
2BCMB (CORRA) NS (Ku+GMI) V06A

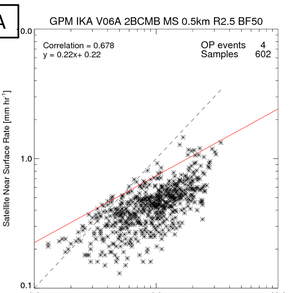


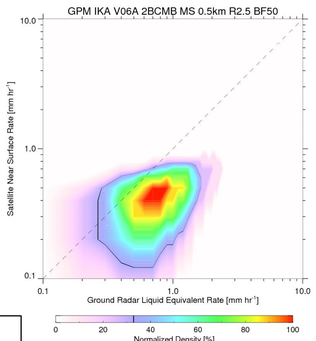




2BCMB (CORRA) MS (Ku+Ka+GMI) V06A



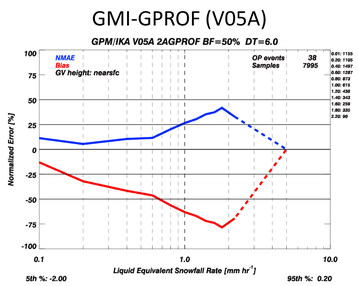


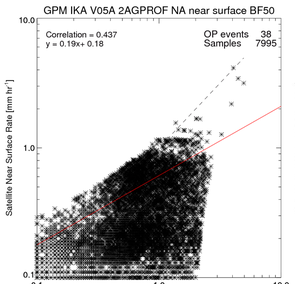


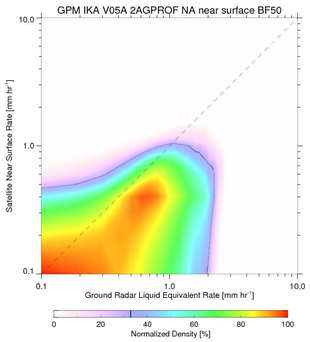
(GMI-GPROF (V5) SWER (y-axis) vs. IKA *Radar SWER (x-axis) Winter* 2014/15, 2017/18.

NMAE = mean(abs(satellite-ground)) / mean(ground) – abs(weighted_bias)*
* weighted bias: single bias value weighted by no. obs. within each rate bin.
BIAS = mean(satellite-ground) / mean(ground)

GMI-GPROF (V05A)







GMI-GPROF
Low bias becomes more pronounced as rates increase.
Biased low ~ 12 - 70% depending on rate.
No significant difference between 50% / 90% BF.

Radar based products:
Low bias becomes more pronounced as rates increase.
Low bias approaches ~ 60% at 1.0 mm/h.
No significant difference between dual / single freq.
No significant difference between 50% / 90% BF.

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